This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

Godfrey Lowell CABOT SCIENCE LIBRARY
of the Harvard College Library

This book is
FRAGILE
and circulates only with permission.
Please handle with care
and consult a staff member
before photocopying.

Thanks for your help in preserving
Harvard's library collections.

Eng.

A DISCUSSION

OF THE

EXPLOSION OF BURNING FLUID,

WHICH TOOK PLACE AT SALEM, FEB. 24, 1852,

AND OF SEVERAL OTHERS OF RECENT OCCURRENCE.

BY E. N. HORSFORD,

Rumford Professor in Harvard University.

PRESENTED TO THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

BOSTON:

H. MASON, TRAVELLER JOB PRESS, STATE STREET.

1852.

A DISCUSSION

OF THE

EXPLOSION OF BURNING FLUID,

WHICH TOOK PLACE AT SALEM, FEB. 24, 1852,

AND OF SEVERAL OTHERS OF RECENT OCCURRENCE.

BY E. N. HORSFORD,

Rumford Professor in Harvard University.

PRESENTED TO THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

BOSTON:

H. MASON, TRAVELLER JOB PRESS, STATE STREET.

1852.

Eng 1258.52

HARVARD COLLEGE
June 1, 1928
LIBRARY

Transferred from Harvard Observatory

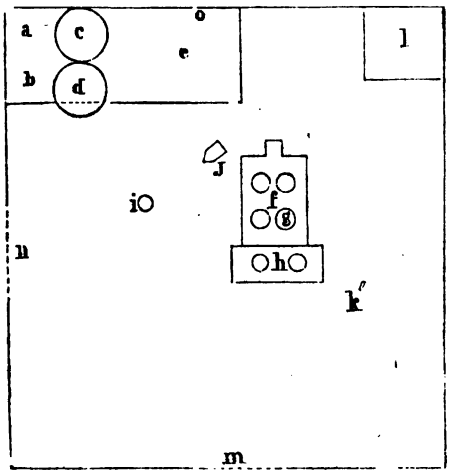
DISCUSSION.

It will be remembered that within the last few weeks several serious accidents have occurred from explosions in the use of burning fluids.* One in Hamilton, by which the lives of two children were lost, one in Georgetown, by which the life of a lady was greatly endangered, and another in Salem resulting in death, have attracted more than usual attention. The first and second presented in the circumstances of the explosion nothing beyond the reach of accepted modes of explanation. The third, however, displayed features so very unusual that many persons have been led to believe in the possibility of the *spontaneous* explosion of burning fluids. This view, which gained great publicity, is so entirely opposed to all that has hitherto been known of burning fluids, that I requested a gentleman residing in Salem, Thomas Cole, Esq., to ascertain from personal inspection of the locality where the accident in that city occurred, and by inquiries of the family, such details as might throw light on the cause of the explosion. This request was kindly complied with. Dr. A. L. Pierson, who with Dr. E. B. Pierson devoted parts of several successive days to a most careful examination of all the circumstances of the accident, has furnished me the result of their labors in a lengthy article in the Salem Observer. Mr. Charles L. Peirson, of the Engineer Department of the Scientific School, has prepared for me a detailed drawing from admeasurements made on the spot by himself, and also the accompanying cuts. More recently, in company with Dr. A. L. Peirson, I have personally examined the locality and studied as carefully as I might all the facts bearing upon the explanation of the case. The following account of the accident for is the most part, condensed from Dr. Peirson's article in the Salem Observer:

The explosion took place at about 11 o'clock A. M. in an unfinished apartment —an addition to the main building, 9 feet by 10, open to the ridge pole and 6

*I use the term "*burning fluid*" as applying to mixtures of high proof alcohol and spirits of turpentine. Camphene is pure spirits of turpentine. Phosgene is a burning fluid, containing a larger proportion of spirits of turpentine, and a purer alcohol. The chemical oils, pine oils, patent fluids, &c., are essentially either mixtures of alcohol and spirits of turpentine, or pure turpentine, or one or both of them, with a small per centage of some oil, which volatilizes at a higher temperature, and which, while it lessens the rapidity of consumption, reduces the illuminating power. These mixtures are sometimes colored with curcuma. Much of what follows in regard to the properties of burning fluid vapor, applies also to the vapor of pure turpentine.

feet high at the eaves. A little to the right of the centre of the room, (looking from the main building) was a cast iron cooking stove, unusually thin and very smooth. At a distance of 6 feet from the stove and 3 feet from the floor, on a shelf in the corner of the room, partially sheltered from the direct heat of the stove by two intervening water pails, was the tin gallon can which exploded. It was about half filled with burning fluid, and had of course been repeatedly opened in serving the lamps in daily use. The neck or larger opening of the can was stopped by a pine plug, which, although pressed to its place with difficulty from the irregular surfaces of both stopper and neck, closed the passage but imperfectly, leaving a space more than half around the stopper of a diameter continuous from top to bottom varying from a twentieth to a twelfth of an inch. The nose, or smaller opening, was closed by a rag stopper. The accompanying diagram will illustrate the interior of the apartment at the time of the explosion:



a. Can.
b. Shelf.
c. Empty water pail, burned on inner and outer sides nearest the can.
d. Full water pail.
e. Sink.
f. Stove.
g. Place of tea kettle.
h. Stove hearth.
i. Can bottom.
j. Can sides and top.
k. Can neck and plug.
l. Chimney.
m. Door leading to the main house.
n. Door leading out.
o. Window.

About fifteen minutes before the accident, the girl, the unfortunate sufferer, rekindled with shavings and pine wood the fire in the stove, (which since breakfast had not been replenished). and set in its place on the stove, a tea-kettle containing about a quart of water. The mother, a few moments before

the accident, lifted one of the kettles from its place on the stove, and observed that the fire was burning well, and that a space about two inches in diameter on the top of the stove, was red hot. As the mother left the room, the girl tipped the tea-kettle to pour some boiling water into a vessel on the stove hearth by inclining, not removing the kettle. An instant after the explosion occurred. The fragments of the can were found on the floor, the bottom entirely disconnected from the sides, the nose and neck separated from the conical top, and the seam uniting the top with the sides unsoldered through two-thirds of its circumference, leaving undisturbed the part *nearest* the inner water pail.

The neck, with the plug still in it, was found beyond the stove. The other parts, with the exception of the nose, were found at the points indicated in the diagram. The nose was overlooked at the time of the accident, and afterwards found in rubbish out of doors. The dress of the unfortunate victim of the accident, the clothing recently washed and suspended about the apartment to dry, more or less of the pine wood interior to the ridge-pole, the floor about the fragments of the can, and the doors and boards in front and at the end, enclosing the closet under the sink, all took fire. About half of the outside and corresponding inside of the water pail nearest the can, and which was empty, were burned. The outer pail, which was filled with water, is said to have been scorched a little on one side.—*Only the shelf on which the can stood, and the boards in the corner on two sides of it, were not burned.*

The above account embraces the essential circumstances of the case, as derived from the statements of surviving inmates of the household, and from the evidences in the appearance of the locality after the accident.

An explanation of the explosion that shall meet all the wants of the case is far from being obvious at a first glance. After as careful an examination of all the testimony as I have been able to give, I submit the following explanation as the most satisfactory and as being entirely in accordance with the facts. I preface it with the mention of a few principles and facts with which most persons are familiar.

The term *explosion* is generally given to nearly all accidents with burning fluids, but more strictly applies to very sudden and great expansion accompanied with a sharp noise. It may be expansion from solid to gaseous, as in the case of gunpowder, or from liquid to gaseous, as when the water of an over-heated boiler flies into steam with the bursting of the boiler, or in mixed gases passing from one form to another, as when hydrogen and oxygen explode to form aqueous vapor, or as when the "fire damp" of mines—(mixed coal gas and atmospheric air)—explodes to form "choke damp" and aqueous vapor. The violence of the report attending the expansion will be proportioned to the resistance, ultimately and suddenly overcome, by which the expansion is opposed.

A pistol charge of gunpowder scattered on the floor, if fired would explode with little noise compared with that which would attend its explosion from the pistol barrel, carefully rammed down before firing.

Most if not all explosions are directly or indirectly due to increase of heat. This agency gives to the particles of the explosive body a condition of unstable equilibrium, in which they take on new chemical relations requiring more space; or it invests them with repulsive tendencies alike demanding more space. An explosion of the first class requires but a momentary application of heat more or less intense. One of the second class generally requires a prolonged application of heat, by which the temperature of the liquid is raised much above its boiling point, and that under circumstances not permitting gradual expansion. One of the third class requires a momentary application of heat, but of high intensity. The above remarks are made as general illustrations, and are not intended to include all possible forms of explosion.

Oil of turpentine, which is an ingredient of all the burning fluids in use, may be regarded as a kind of liquid coal gas. It boils at 314° Fah. (water boiling at 212°, and alcohol at 176°) The mixtures of rectified alcohol and oil of turpentine, constituting the burning fluids of dealers, boil at a temperature lower than the oil of turpentine according to the proportion of alcohol. Each ingredient by itself and the mixture of the two vaporises at ordinary temperatures.

In order to convert burning fluid so suddenly into gas as to have the transition accompanied by a report as of an explosion, it must manifestly be heated at least as high as its boiling point— the point at which it takes on the gaseous form suddenly. Indeed, experience has shown that even this temperature applied to an open vessel containing burning fluid will produce only the noise of boiling. In order to an explosion of the liquid, not only is a high heat required, but the liquid must be confined as water within a boiler. Then with sufficient heat explosion would result with the burning fluid and also with the water. Such an explosion, however, would be unattended with flame, unless an incandescent body like flame for example, came in contact with the liquid or vapor scattered about by the explosion.

On the other hand, an admixture of the *vapor* of burning fluid with atmospheric air in certain proportions, upon the application of flame will explode.* Its properties are like those of the mixture of coal gas and atmospheric air in mines. Nearly all the accidents of this description have occurred in attempts

* This is true of the vapor of all the burning fluids in use, not excepting Marsh & Newall's, at one time stated by the proprietors to be perfectly safe to use in any common oil lamp. It is due to Mr. Newall to state that, upon being shown that the burning fluid of his establishment was quite as liable to accidents from explosion as any of the others in use, he promised to withdraw immediately that feature of their advertisements, which conveyed so erroneous an impression, and in which they had, however unintentionally, so greatly trifled with the lives of the community.

to fill lamps in the presence of flame from a can partially emptied, or from the top of the lamp or can being defective or so imperfectly closed as to let the flame communicate from without to its interior. From having made the circumstances of these explosions a subject of experimental study within the last three years, my attention has been more particularly drawn to the accounts of accidents that have appeared from time to time, and I do not now recall an instance that does not admit of explanation upon the principle that flame or some other incandescent body was brought in contact with mixed spirit vapor* and atmospheric air. The same view is, I learn, entertained by the present head of the oldest house, dealing in burning fluid and camphene, in the country.

The Hamilton case was clearly one of this description. The lamp had two wick tubes. The wick had been withdrawn from one of the tubes, and to prevent flame from communicating with the liquid, a pine stopper had been driven into the tube. Unfortunately it was too large and split the tube open This established the very communication it had been designed to prevent, and in an unlucky moment flame was communicated to the aperture and explosion ensued.

The Georgetown case is, I am persuaded, one of the same description. Dr. Pierson has procured for me the fragments of the lamp which exploded in this case. I find on examining the plaster of Paris with which the metallic top was secured to the glass part of the lamp, that it is exceedingly brittle; some of it is loose, and portions of it had fallen out. Lamps similarly made and sometime in use in my family have lost so much of the gypseous cement, by its becoming pulverulent, that the fluid with a little agitation frequently issues through the opening and runs down the outside of the lamp. The Georgetown lamp had doubtless lost some of this cement, and in carrying the lamp† the incidental agitation of the fluid had caused some of it to issue through the space between the top and the glass, and this being fired from the flame, communicated to the interior and produced explosion. An opening less than the fortieth of an inch in diameter is large enough, as I have ascertained by experiment, to transmit the burning fluid flame to an explosive mixture.

The Salem case present difficulties of very considerable moment, among which the following may be mentioned.

1st. How fire could have been communicated to the mixed vapor and atmospheric air in the can at a distance of six feet from the stove, the only source of fire in the room.

2d. How an explosion could occur by which burning fluid should be thrown on the outside and corresponding inside of the water pail nearest the can, and not on the shelf or the boards in the corner.

* The term is applied to the vapors of all liquids that burn.
† The lady was carrying the lamp when the explosion occurred.

3d. How this could take place, produced by the explosion, with no opening on the side of the can nearest the water pail.

4th. How fire having been communicated to the contents of the can in its proper place, explosion should not have thrown at least the empty pail from the shelf.

5th. And how, since the pails were neither of them moved by the shock, an explosion could cause the can to leap over the pails and fall upon the floor some four or five feet distant.

These inquiries present some of the apparently contradictory phenomena which any attempt at an explanation must encounter.

The communication of fire has seemed to be the principal difficulty in the case. It has been suggested that the rag stopper saturated with the burning fluid might have taken fire, as "cotton waste" (cotton more or less saturated with oil) has been known to take fire. This explanation cannot be sound. Burning fluid vaporises at a low temperature. In vaporizing it absorbs heat. The purer varieties absorb so much heat that a low wick is but slightly charred after an evening's burning. It is quite obvious, therefore, that heat enough to inflame a body so volatile could not be derived from the spontaneous oxidation of the body itself.

Nevertheless I made several experiments upon the point, thinking that exposure might by oxidation produce, possibly, so much resin in the burning fluid, and the rapidity of volatilization be thereby so much reduced, that the conditions of the rag stopper and waste cotton would more nearly approximate and spontaneous ignition occur. The result, however, was a negative one. It could not have been otherwise. With the reduced volatility came diminished oxidation, so that what was gained in one way by the process was lost in another.

It has been maintained that since the daughter had on one or two occasions been known to employ the burning fluid in kindling the fire and to amuse her younger sisters, that she had in all probability been so occupied just before the accident, and had left the can near the stove, where the larger part of it was found after the explosion. To this the mother replies that, after hearing of the accident in Hamilton, the daughter became greatly alarmed, and wished to have the burning fluid altogether removed from the house; that there could not have elapsed time enough after the mother left the room and before the explosion occurred, for the girl to have gone to the can, if she had had any occasion to employ it; that she (the mother) walked to the sink to wash her hands just before leaving the room, and in so doing passed over the spot occupied by the can according to this supposition; that the daughter was left pouring hot water from the teakettle on the stove, into the bread-tray; and finally that the girl made no allusion after the accident as to its mode, inquiring only if the children had any of them been burned.

We need not distrust the representations of the living sufferers by so melancholy an event, without first exhausting the resources of science in seeking a legitimate explanation; and I may remark that no statement made by the afflicted mother is inconsistent with the conclusions to which investigation has led.

The impression that the wooden stopper fitted closely has precluded an attempt at the natural explanation. This impression was based upon two circumstances: first, that in the explosion the plug and neck were not separated; and second, that no smell of burning fluid was ever noticed in the room. In regard to the first, it is easy to see that a four-sided stopper of the requisite size might be driven into a cylindrical neck so tightly as to be extracted only with great effort; and to the second, very considerable quantities of burning fluid vapor may be in a room without its being observed, as I have ascertained by placing small quantities in a number of vessels permitting ready evaporation, and by sprinkling it on the floor. The space between the pine plug and the neck I have found to be of at least twice the diameter required to transmit flame.

A mode of explanation has been based upon facts like the following:— A few years since, a lady while washing her hair in alcohol in a small apartment from which fire in every form was excluded, upon the presentation of a burning lamp at the door, was startled by a sudden explosion, and thereafter fearfully burned. The mixture of alcoholic vapor and air had become explosive. Two similar accidents have recently occurred, one in New York and another in a Southern city, from carrying lighted lamps too near open casks containing spirits. The explosive mixture of spirit vapor and air about the casks was fired from the flame and communicating to the interior of the casks, caused explosion.

Such facts as these have suggested that the burning fluid vapor slowly exhaling from the can diffused itself through the lower strata of air, gradually filling the apartment from below with an explosive mixture which coming in contact with incandescent portions of the stove, or on being drawn into it, took fire and communicated flame to the can. To this it may be objected that the weather was cold, and the time for producing such a quantity of vapor after the kindling of the fire had not elapsed. The fire seems to have been burning but about fifteen minutes when the explosion occurred.

Dr. J. R. Nichols of Haverhill, Mass., and Dr. C. T. Jackson have suggested that a train of vapor might have led to the stove from the can, have fired, and conducted flame to the can.

This suggestion is based upon facts like the following: Mr. Collins of Haverhill, an acquaintance of Dr. Nichols, witnessed the flame from a lamp

flit through a space of at least four feet to a burning fluid can. A similar phenomenon has been frequently observed in the use of ether. A lighted lamp creating a draught toward itself, has taken the exhaling ether from an open vessel along the top of the table to the flame, and fired it, and the train has conducted the flash to the bottle. An officer of our navy has informed me that he once witnessed the leap of flame from a burning lamp through at least eight feet of space, from a lantern to an unstopped bottle of ether.

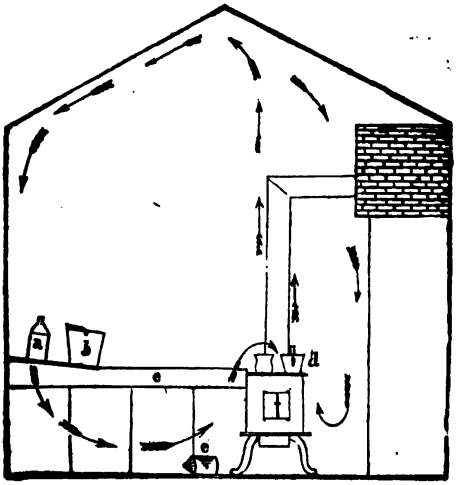
The difficulties which the positions of the can and stove, their relative heights and the intervening depth of space offer to the first suggestion, are not so formidable in opposition to the second. The narrowness of the apartments at Salem, the moderate height of the roof and its convergence to a ridge-pole from the eaves, would produce, upon suddenly heating the stove, a strong current of air upward around the stove-pipe, and a less rapid, because a broader, descending current on the sides of the room, and particularly on the side more distant from the stove. The exhalations from the can, augmented by the heat of the descending current of air, would be taken into this stream and carried a little downward from the shelf and then toward the stove, constituting a slender continuous train of explosive mixture, stretching outward from the neck of the can. On nearing the stove it would join the upward current. On lifting the kettle from the stove, a large volume of air would rush in at the opening and this stream of burning fluid vapor with it. It would fire and the flame fly back to the can. It is conceivable that the slender train of burning fluid vapor would have preserved this necessary definiteness of outline, as we see in the column of white smoke that ascends from an oil lamp or tallow candle just blown out, (and along which flame has been known to run several inches,) and that precisely time enough might have elapsed between the firing of the wood and the lifting of the tea-kettle, to have the current, descending in irregular ellipses on all sides of the stove, bring the burning fluid vapor to the point required for the explosion. A few moments later, the equilibrium of temperature would have been restored throughout the apartment, and the current have become too irregular to conduct the stream of burning fluid vapor with sufficient definiteness of margin to the stove, to make explosion possible. The accompanying diagram will serve to illustrate this view.*

---

*The following view is that to which I was first led. I am now satisfied, however, that it is less probable than the foregoing:

It will be recollected that the fire was of shavings and pine wood, and that the mother observed a minute or two before the explosion, that it burned well, and that a portion of the stove was red hot. Upon inquiry, she told me that the pine wood used would snap. It is conceivable, then, that when the daughter inclined the tea-kettle, as she did just before the explosion, that a bit of glowing coal was thrown through the open passage to the neck of the can. The increasing warmth of the apartment had driven a little of the mixed vapor and air through the space between the plug and neck to the air above, increasing somewhat the area of the target against which the shaft was aimed; and that this explosive mixture was fired, and the flame ran back into the can.

It has been suggested that this mixture cannot be fired from a coal. If this criticism were sound, we should never be able to kindle a fire resulting in blaze, from coals. Among the products of destructive distillation when wood is subjected to heat, are carbo-hydrogens



a. Can in its place on the shelf.
b. Outer water pail filled with water.
c. Sink.
d. Kettle lifted by the girl.
e. Can after the explosion.

The expansion attendant upon the explosion would press outwards in a directions the walls of the can. If all could not yield alike, the least firm would obey the impulse. The conical top is not constructed to yield without rupture to pressure from within. The vertical sides are alike unable to give increased space without rupture. The plug and neck, offering less resistance, would be blown off. The bottom, being a plane, could be pressed downward so as to form an obtuse cone. As the shelf, however, is firm, the depression of the centre of the bottom must be attended with the elevation of the whole body of the can, and the sudden downward movement of the bottom would cause the can to spring into the air. The shelf was inclined toward the sink, and the outer half also inclined a little outward. This inclination would give the upward movement of the can a direction from the perpendicular, and if the can were seated on the outer half, a direction outward from the shelf and sink. The latter supposition is a little more favorable to the view taken, but not essential. With a velocity that would carry the can to the inclined roof, it is easy to see how the nose could have been broken, (the neck and plug having been separated by the explosion) and with the momentum acquired, how a quantity of the fluid would rush out upon the rafter or inside of the roof, and some of it fall. The

analogous to the vapor of burning fluid, which with atmospheric air form explosive mixtures. The slight explosion that accompanies the commencement of a blaze of wood, or a candle, or lamp, when heated by a glowing coal, illustrates not inaptly the truth of this remark. The following paragraph from Sir Humphrey Davy's researches upon explosions, (p. 75, Vol. 6th. Smith, Elde. & Co., London, 1840,) bears upon this point:

"The ratio of combustibility of the different gaseous matters, is likewise, to a certain extent, as the masses of heated matter required to inflame them. An iron wire of 1-40 of an inch, heated to a cherry-red, will not inflame olefiant gas, but it will inflame hydrogen gas; and a wire of 3-8, heated to the same degree, will inflame olefiant gas; but a wire of 1-500 must be heated to whiteness to inflame hydrogen, though at a low red heat it will inflame bi-phosphoretted gas; wire of 1-40, heated even to whiteness, will not inflame mixtures of fire-damp."

can, as the resultant of the collision of its irregular form with the inclined inner surface of the roof, would acquire more or less of a whirling motion, and scattering fluid in its way, would ultimately reach the floor. A jet of it falling upon the stove would instantly enshroud it and the girl by its hearth, in flames. The heat of the burning fluid about the can would melt the solder, release the bottom, and such parts of the soldered seams as were not protected by the fluid. The line of attachment of the conical top to the sides, the opened seam of the top itself, the undisturbed ear to which the bail was, on one side secured, and the gathering of the molten solder in the same region, all are in keeping with the idea that the can lay partially immersed in, and so far protected by the fluid on the floor.

To return to the point of collision of the can with the roof. What point on the shelf would a small quantity of fluid reach thrown out against the roof and falling perpendicularly? A place manifestly lower on the inclined shelf than that occupied by the can. And although it may not now be susceptible of absolute demonstration, by admeasurement, since the exact position of the articles is not known, it is obvious upon an inspection of the premises, that the point a liquid would reach, falling from the intersection of a line to the roof, drawn from the can's place perpendicularly to the shelf, must have been very near the edge of the pail. Indeed, it is difficult, if not impossible to see how just liquid enough to have fired the outside and inside of one of the pails, and not the shelf or surrounding surfaces, could have come in any other direction than from above.

This view leaves no statement of the surviving inmates, or fact of the appearances, as presented after the accident, without a legitimate explanation.

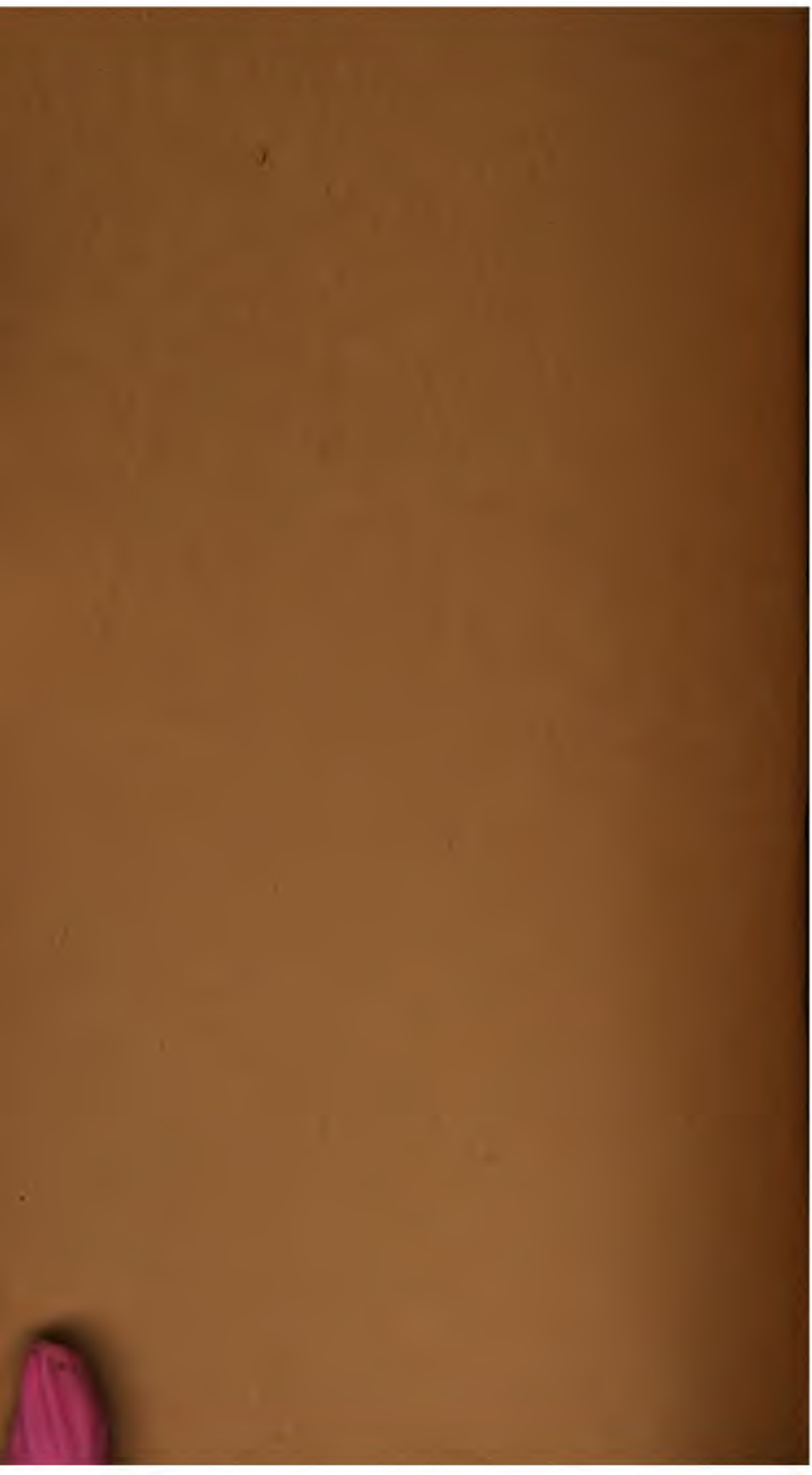
In conclusion, then, it may be stated in regard to the Salem case,

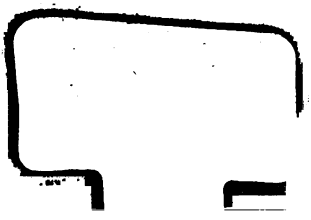
1*st*, *That the explosion was caused by bringing a mixture of burning fluid vapor and atmospheric air in contact with an incandescent body.*

2*d*, *That the evidence does not require us to believe in the spontaneous explosion of burning fluids.*

NOTE.—In investigating the above cases of explosion, I have been led to study the conditions of explosion generally, and with them the causes of the numerous other accidents that have occurred in the use of burning fluids, with a view to devising such expedients as should render safe even in the hands of unskilled and careless persons the use of so cleanly, economical and desirable a source of artificial illumination. In these I have been successful. I had nearly completed my plans when I was called upon by Dr. Nichols, of Haverhill, in this State, who had devoted much time to the same subject and had fixed in general upon the same expedients to which my experiments and reflections had conducted me. This gentleman proposed to engage in the manufacture of the lamps.

I have acquiesced in a proposition to give him whatever hints may result from my investigations, and am now preparing an article describing the devices and improvements which have suggested themselves to me. This article will soon be ready for the press.





Eng 1258.52
A discussion of the explosion of bu
Cabot Science
004942749
3 2044 091 967 620